DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
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THE MINERAL INDUSTRY

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

THE MINERAL INDUSTRY (1)

By Scott Turner (2)

Within recent years, people have begun to realize the importance and significance of the mining and allied industries. The leading part the engineer plays in civilization is becoming recognized. However, accurate quantitative knowledge of the industrial importance of mining is still seldom possessed except by those close to this business. It is true that there are a few who go to the extreme and represent the whole progress of civilization as a reflection of man's gradual mastery of mineral utilization, but on the whole, the magnitude of the industry is underestimated.

The uncertainties of mining, as evidenced by the variable results of prospecting on surface or underground, in an unknown new field or from the bottom levels of a mature mine, the ins and outs of tonnages and metal contents, the possibility of a widespread or even a sudden change between cost and realization-price, add to its picturesqueness and make mining attractive to some. To many, the fact that results are generally more uncertain and less predictable than in other industries lends added charm.

The following pages may serve to call attention briefly to the importance of mining relative to other industries in the United States, in Canada, and in the world.

Ordinarily, the annual primary mineral production of the United States amounts to about 5½ billion dollars. The average for the last five years has been a little over 5½ billion dollars. Last year, sadly enough, it was less than 3½ billions. Just now, we are on the decline, and have been for the past two years. In Canada, the 5-year average was about 268 million dollars. Last year it was 227 million. Due in part to gold output (in 1930, for the first time, Canada's gold production exceeded that of the United States), the Canadian average is holding up better than ours. It has been estimated that the average world mineral production over the past five years has amounted to about 12 billion dollars, while in 1931 it was less than 8 billions.

The mineral industries are as indispensable for the conduct of modern society as are those of agriculture, but, in the United States at least, they receive far less recognition from the Government. With us, agriculture is fostered by a great department that is maintained by enormous appropriations, while the mineral industries get but little financial support. In the United States, in the calendar year 1930, the value of production by these two industries were as follows:

Agriculture (inclusive of forestry) 9.9 billion dollars; mining 4.8 billions; ratio 2 to 1. Direct appropriations by our Federal Government were 109 million dollars to agriculture and 2.8 million to mining, a ratio of 39 to 1. Obviously this is out of balance to the extent of 19 to 1 in favor of agriculture.

That is to say, a dollar is appropriated by the Congress of the United States for each $90.60 produced by agriculture, while a dollar is appropriated for each $1,711 produced by

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Epitome of a lecture delivered by the Director of the United States Bureau of Mines before the Royal Canadian Institute at Toronto, Ontario, Canada, on April 16, 1932.

2 - Director, U. S. Bureau of Mines.

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mining. This constitutes a bold defiance of realities made possible only by the relatively late development of mining in a world previously preempted by agriculture and trade. Why government now continues to accord 19 times as much support to one basic industry as to another, can only be explained by the knowledge of the political factors involved.

The latest available figures for Canada are about as follows: The primary annual production of agriculture amounts to 1.9 billions; of mining, less than 0.3 billion; ratio 6.9 to 1. Appropriations were $10,870,000 to agriculture and $921,000 to mining, a ratio of 11.8 to 1. The discrepancy in treatment of the two industries thus indicated is comparatively slight, as a dollar is appropriated by Canada for each $174 of agricultural production compared with a dollar for each $299 of mineral production, the ratio here being 1 to 1.7.

Minerals are mined, but after they are won from the earth their subsequent treatment involves vast and complex industries the conduct of which requires much more skill and thoughtful direction than agriculture, and the welfare of which is probably of greater importance to society as now constituted in our countries.

It has been estimated that when we in the United States are producing, say 6 billions annually (we have exceeded 6½ billions), the employment of 2 million workers provides indirect support to perhaps 10 million people. When the raw materials furnished by our mines have been refined, processed, and fabricated, their wholesale value is over 15 billion dollars, and during this second period another 2 million workers have been kept busy, thus supporting another 10 million people. The third stage is distribution to the ultimate consumer, and this trade amounts to about 20 billion dollars, perhaps supporting 5 million more people. Thus we account for the livelihood of 25 million of our people. It has been estimated that on raw minerals alone the industry pays direct taxes to the Government totaling five times those paid on all the other raw-material industries combined.

In the 40 years from 1886 to 1926, per capita mineral production in the United States increased from $7.87 to $53.34, or sevenfold, while that in Canada increased from $2.23 to $25.61, or elevenfold. In 1886, production per person in the United States was 3.5 times greater than that in Canada, but the discovery of gold in the Klondike increased the Canadian mineral output so rapidly that by 1901 per capita production was almost equal to that of the United States. Thereafter, per capita production increased less rapidly in Canada than in the United States, resulting in a ratio of about 1 to 2 in 1926. During the current depression, mineral production has declined much less in Canada than in the United States, so that in 1931 the per capita production again is only slightly in favor of the United States, as will be shown later.

Per capita production of minerals

Year	U. S. A.	Canada	Ratio Canada to U. S. A.
1881	$7.82	(1)	(1)
1886	7.87	$2.23	1:3.5
1891	9.34	3.93	1:2.4
1896	9.04	4.42	1:2.0
1901	14.86	12.25	1:1.2
1906	22.15	12.85	1:1.7
1911	20.54	14.32	1:1.4
1916	34.82	22.05	1:1.6
1921	38.25	19.48	1:2.0
1926	53.34	25.61	1:2.1
1931	25.05	21.93	1:1.1

1 - Not available.

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It is a surprising fact that there exists no record of the value of the world's mineral output. To arrive at a reasonable figure, it was necessary to establish some method of estimation. This was accomplished by selecting 13 minerals for which world production data were available, including most of the principal metals, coal, petroleum, and some other non-metallics. Quantity-production of these minerals in the United States, Canada, and the world was tabulated for certain years, converted into figures representing value, and then totaled. These totals for the United States and Canada were then compared to their total mineral productions. The ratios obtained by this comparison were then applied to the value of the world production of the 13 selected minerals to obtain an estimate of the total world mineral output, which thus appears to be, for 1929, $14,500,000,000.

The following table compares the mineral production of the United States, Canada, and the world for 1886, the first year for which data are available, and for 1900, 1910, 1920, and 1929.

Rate of increase in the mineral production of the United States, Canada, and the world

Year	U. S. A.			Canada			World (1)		
		Increase			Increase			Increase	
		1886	1900		1886	1900		1886	1900
	Value	=1	=1	Value	=1	=1	Value	=1	=1
1886	$ 456,185,000	1.0	0.4	$10,221,000	1.0	0.2	$1,500,000,000	1.0	0.4
1900	1,108,936,000	2.3	1.0	64,421,000	6.3	1.0	4,200,000,000	2.8	1.0
1910	1,987,844,000	4.2	1.8	106,824,000	10.5	1.7	5,700,000,000	3.8	1.4
1920	6,981,340,000	14.6	6.3	227,860,000	22.3	3.4	17,000,000,000	11.3	4.0
1929	5,887,300,000	12.3	5.3	307,146,000	30.0	4.8	14,500,000,000	9.7	3.5

1 - Estimated.

We all should be interested in the question of mineral production per capita of total population, in the United States and Canada, and of relatively greater increase or decrease in these two countries.

In the United States, the value of mineral production was $5,887,300,000 in 1929, and $4,810,400,000 in 1930. Since the total population in April, 1930, was 122,775,000, the mineral production per capita was $47 in 1929 and $39 in 1930.

In Canada, mineral production was $307,146,000 in 1929, and $279,873,000 in 1930. Population in June, 1930, is estimated at 9,934,000, indicating a per capita production of $31 in 1929 and $28 in 1930.

In the 43 years from 1886 to 1929, the mineral production of the world increased nearly tenfold, that of the United States over twelvefold, and that of Canada thirtyfold. Yet, notwithstanding the large increase, Canada's output was equivalent to only 2 per cent of the world total and to 5 per cent of the United States total in 1929. The average increase per year as determined by contrasting 1886 with 1929 was as follows:

World	$302,000,000
United States	126,000,000
Canada	7,000,000

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The growth of total mineral production in Canada (since 1900) closely parallels that of the United States. Comparing the average total yearly output from 1901 to 1905 with that from 1926 to 1930, it is found that Canadian production increased 4.2 times while that of the United States increased 4.0 times. Growth of the three main branches of mineral production, however, showed considerable variation. For the same two 5-year periods, metal production increased 3.7 times in Canada and only 2.2 times in the United States; fuels increased 5.6 times in the United States and only 4.3 times in Canada. Nonmetallics showed a higher rate of increase in Canada than in the United States, the ratios being 5.9 and 4.5, respectively.

Ratios for all 5-year periods from 1901 to 1930 are shown in the following table:

Rate of growth of production of fuels, metals, and nonmetallics in the United States and Canada by 5-year averages, 1901-1930, expressed in terms of average production from 1901 to 1905

Period	Total		Metals		Fuels		Nonmetallics	
	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada
1901-1905	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1906-1910	1.4	1.4	1.3	1.2	1.4	1.6	1.4	1.7
1911-1915	1.6	2.0	1.4	1.7	1.8	2.1	1.6	2.8
1916-1920	3.7	3.1	3.1	2.7	4.7	3.6	2.8	3.6
1921-1925	3.7	3.1	2.0	2.3	5.4	4.1	3.9	4.3
1926-1930	4.0	4.2	2.2	3.7	5.6	4.3	4.5	5.9

The importance of metals, fuels, and nonmetallics in the mineral production of the United States and Canada presents some interesting contrasts. From 1901 to 1930, the relative importance of metal production in the United States declined, while that of fuels and nonmetallics increased. The same transition has taken place in Canada, though it is much less pronounced. Comparing the 5-year periods 1901 to 1905 and 1926 to 1930, it is found that in the United States metals declined from 42 per cent of the total mineral production to 23 per cent, whereas in Canada the decline was from 56 to 48 per cent. During the same periods, fuels increased from 39 per cent to 55 per cent in the United States and from 26 per cent to 27 per cent in Canada. Nonmetallic production increased from 19 to 22 per cent in the United States, and from 18 to 25 per cent in Canada. In recent years, metal production in the United States, and fuel production in Canada, are of the same order of importance with respect to the total mineral output of the two countries; a similar relation exists between fuels in the United States and metals in Canada. Nonmetallics have about equal importance in the two countries.

These various relations are shown in tabular form below:

Relative importance of metals, fuels, and nonmetallics in the mineral production of the United States and Canada by 5-year averages, 1901-1930, in per cent

Period	Total		Metals		Fuels		Nonmetallics	
	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada
1901-1905	100	100	42	56	39	26	19	18
1906-1910	100	100	41	49	39	30	20	21
1911-1915	100	100	37	48	43	28	20	24
1916-1920	100	100	35	49	50	30	15	21
1921-1925	100	100	22	41	57	34	21	25
1926-1930	100	100	23	48	55	27	22	25

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In the United States, the mineral industry does not constitute as big a business as manufacturing and agriculture combined, but it is about on a par with railroad transportation. The mineral industries include, in addition to mines and quarries, the mills, smelters, iron blast furnaces, coke ovens, petroleum refineries, oil and gas pipe lines, manufacturies of clay products, lime, and cement, and many other activities; the practice is not to include steel works and rolling mills, which are generally classed as fabricating industries.

We have noted that roughly 2 million men are employed at or in our mines, which is a little greater than the number occupied in railroad transportation; about 800,000 work underground. Our coal mines alone employ many more men than are used in any manufacturing industry. With us, it is estimated that about 1 man in 40 works in the mines, whereas in Great Britain it is stated that 1 man in 10 is employed underground.

While it is well known that the railroads depend upon the products of the mines for more than half their tonnage, it is not so generally understood that this figure indicates these products in their raw condition, as mined, and does not include the tonnage involved in reshipments for reworking at smelters, refineries, at the large nonmetallic fabricating plants, and at the beneficiating establishments of the mineral-fuel industries. The oil business alone gives the railroads a tremendous tonnage from its refineries; the increased use of oil pipe lines thus gives the railroads much concern.

The annual production of the mines, which, as we have seen, has averaged nearly 6 billions during the past five years, is large as compared to the capital-investment in this industry, which is said to be something over 12 billions; thus annual production is half of investment, whereas the railroads, for example, exclusive of electric lines, annually produce an amount equal to one-fourth their capital investment of approximately 24 billion dollars.

The growing importance of minerals to man is readily shown on time charts representing the world production of such basic commodities as the mineral fuels or pig iron, as compared to the total white population. During the past century, while the production of pig iron was multiplied by more than 100, and that of the mineral fuels by about 75, with other metals taking similar courses, the white population of the world only increased about threefold. The production of minerals during the century ending in 1914 increased quite regularly from 5 to 7 per cent per year.

Among the better-known metals, during the past century zinc production increased at the most rapid rate, - in fact more rapidly than iron; copper comes next, closely paralleled by lead; then silver; and while gold production fluctuated more on account of two rapid rate-increases (about 1850, and again 50 years later), it also shows a marked increase during this period.

It has been estimated that more fuel and more metals have been used during the last 25 years than during all the time that went before. This regular and colossal increase could not continue; it is already slowing, and many believe that from now on the growth will be at a diminishing rate, as sharply contrasted with an increasing rate since the end of the eighteenth century.

It should be a source of satisfaction to the engineer to note that while production and wages have increased, unit costs have steadily gone down, both actually and as considered in comparison with accepted figures of general price level. The improvements in mining and metallurgical practices responsible for this lowering of cost have come by gradual evolution rather than by sudden change; the good results have been achieved through the experience and inventive genius of many men, perhaps working in widely separated regions and not in direct collaboration, but all contributing to progress in the art of mining. The most important single factor here has been a steadily increasing output per man-shift, in which America has led easily. Improvement in transportation has been important, while improved technology and more abundant and flexible mechanical power have helped throughout.

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Exploiting mineral deposits is peculiar in certain regards, since the deposits are exhaustible, are of rare occurrence when measured in terms of outcrop-area as compared to total earth area, and may suddenly be handicapped or superseded by new discoveries; moreover, the economic position of the contained metals is affected by the use of scrap metal and the existence of invisible stocks.

The first characteristic, exhaustibility, is nearly monopolized by mining, although destructive cutting of virgin timber, ruthless overattack of naturally-fine fishing grounds, and thoughtless exhaustion of newly-cultivated soil faintly resemble it. Other factors remaining constant, each ton of ore extracted leaves the mine with a smaller reserve, less gross value, and shorter life. Agriculture, forestry, fisheries, water power — all these involve the idea of constant fertility, growth, and replenishment. The orebody as an asset wanes steadily during exploitation. Depletion of the capital represented by the mineral deposit must be reckoned in accounting; the profits derived from mining often appear greater than they actually are, due to ignorance on the part of the stockholder as to amortization of his investment; the salvage-value of equipment is usually small when the ore is gone.

Many mines follow similar cycles. Discovery is followed by exploration, then exploitation. Experience shows that the ores near the surface are apt to be relatively highest in grade. While the richer and more easily accessible ore is being mined, with new plant, equipment, and crew, tonnage-costs may be high. The tendency from now on is to increase production-rate, handle lower-grade ore, and yet reduce costs per ton and per unit of metal recovered. To many engineers this period is the best, since progress and growth are apparent, while ingenuity and speed are amply rewarded. Imperceptibly the ore becomes poorer; increasing depth, water, temperature, and rock-pressure begin to show in higher costs per unit of metal and later in costs per ton of ore; probably, long before the end of the mineral deposit has been reached, these factors result in unprofitable operation, which after a time, when accompanied by failure to find new orebodies extending from, adjacent to, or in the neighborhood of the old one, lead to final stoppage of work.

The modern tendency is for the operating company, during the prosperous period, and with full knowledge of the progress of depletion and exhaustion, to look for new fields of operation in the same, neighboring, or distant areas; if successful in this, the end of the old operation may overlap the beginning of the new, so that corporate continuity is maintained. But never does the miner secure the comfortable permanence of the agriculturist. For the same plot of rich land to yield consecutive annual crops for five thousand years is not unheard of, and this might stretch to fifty thousand years, or ten times fifty thousand. Some small gold-bearing alluvial deposits may be somewhat replenished seasonally or periodically, but not one vein or lode mine in a hundred has lasted for even 20 years before complete abandonment. In the West, our thousands of forsaken mines, ruined camps, and ghost towns bear mute testimony to this cycle.

The same way that mines are mortal, so, on a larger scale, are mining divisions, districts, and regions. Even great states, nations, countries, and continents exhibit this ever-changing nature, insofar as their mineral resources are concerned. Within the past century, the center of mineral production has shifted from the Eastern to the Western hemisphere, from Great Britain to the United States. The locus of principal production had probbly passed from Egypt to Cyprus, then Asia Minor, Gaul, and to Germany, before moving to Great Britain.

As for the metal copper, the production-center has shifted from Cyprus to Spain to Sweden to Great Britain to Chile to the United States. In the States, the center moved from Michigan to Montana to Arizona. The United States, for half a century the premier copper producer, in which position she will continue for a long time to come, is witnessing what may be the first evidence of the ultimate surrender of her position, as indicated by the petition

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of certain operators for a tariff on copper. For a generation, American copper mines have met all competition boldly, asking no favors of anyone, and dominating the world without artificial aid or protection. Central Africa, which produced copper in very early times, and which may once have been the world's center of production, seems to be destined, in the distant future, again to occupy the premier position.

The same, to a lesser degree, may be said of petroleum. Rumania dominated the oil world for two years, from 1857. The center of production then passed to the United States, whence came more than 90 per cent of the world's supply. In 1898, Russia became the greatest producer, but was overtaken by America in 1902; the major production has since remained with the States. The center of greatest production within the limits of the United States shifted from Pennsylvania to Ohio, then California, Oklahoma, back to California, then Oklahoma, then California, and so on until 1928, when the crown passed to Texas, where it has since remained.

The migration of production-centers is a fascinating study, and this constant shifting has its international, political, and military significances. As before suggested, new discoveries may tend to slow or quicken this movement, as may also beneficiation or the technology of treatment, and the important features involved in the problem of transportation, including waterways, trails, roads, railroads, airways, and pipe lines. Transportation problems differ from technologic problems relating to mining in that the former may be definitely and finally solved for the life of the mine, whereas the latter always remain variable and never reach a fixed or ultimate stage.

How small a part of the earth's crust is underlain by mineral deposits thus far discovered or worked, can be seen by the study of any map showing mining areas. Coal, oil, and gas are apt to be spread wide and thin, but many of the precious-metal deposits dip at steep angles and thus appear small when projected to a horizontal surface-plane. In the United States, the area underlain by known coal, bituminous and lignite, is only about 496,000 square miles, whereas our total area is 3,026,789 square miles. All the anthracite lies under 484 square miles of surface. Our proved oil area is only 7,037 square miles, or 0.2 per cent of our total. Thus if there were no overlaps in our oil and gas areas, the total for both would only be 13,194 square miles, or 0.4 per cent of our total. It is estimated that in the United States, 20.2 per cent of our entire area is geologically impossible for oil and gas, 44.9 per cent is unfavorable, 34.5 per cent may have prospective possibilities, while as noted before, only 0.4 per cent of the total area of the United States is underlain with proved oil and gas. In Texas, at the beginning of 1929, only 0.2 per cent of the surface was known to be underlain with oil, and in California, 0.1 per cent.

Some metallic ores occur in extreme geographic concentration. One small area in Canada produces nearly 90 per cent of the nickel of the world. One tiny tract in Belgian Africa supplies all our radium. No commercial deposits of tin, nickel, cobalt, radium, antimony, or platinum, and practically none of chromium or asbestos are found in the United States. How important internationally and strategically is this fact of intense and irregular localization, can well be realized if we consider what nations are without coal or oil, and glance over the list of so-called strategic minerals, of military importance, and note their narrow geographic and national distribution.

While we are familiar with corporate monopolies, or near-monopolies, in the case of such mineral commodities as radium, nickel, sulphur, diamonds, vanadium, and aluminum, we must also realize that some of these, and others such as helium, constitute national monopolies (in which class potash salts and nitrate used to be included), and their possession makes possible commercial or preferential treaties or secret understandings, which might lead to diplomatic agreements of grave international import. Leith has frequently emphasized the presence of known major mineral deposits around the North Atlantic area, guaranteeing extended industrial supremacy to Europe and North America, and affording particular advantage to the Atlantic seaboard of these two continents.

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Since for the past century we have been going through the heyday of mineral production, while the goose hung high and improved conditions for increased production at lower prices have been visible on every side, we have tended to lose sight of the fundamental concept already stressed in this paper, of exhaustibility of our minerals. Contributing to this blindness, have been the facts that the immediately-available supply has kept up so well, and that the prices of minerals have quite steadily decreased (except during war or strike periods), both in unit cost and also in terms of the general price level of all commodities.

European countries have not fared so well; in the greatest of all mining industries, coal mining, unfavorable factors began to assert themselves in the early 1880's, and output per man has steadily declined since that time. England is an old coal-mining country, originally with wonderful resources. Already she has passed her prime, production per man underground is decreasing, costs are mounting, and the situation is critical. Yet it is said that only 6 per cent of all her coal has thus far been mined! This example of commercial difficulty long before exhaustion is significant! England produces less coal per man underground to-day than she did in the early eighties. As to other resources, it is reported that her most extensive and important deposits of iron, lead, copper, and tin ores have already been mined. Leadership in these things, hers not much more than a century ago, seems to have been lost, perhaps never to return to her.

America's turn will come, although increasing productivity per man was still in evidence up to a year ago, particularly in copper, iron, and other mines, but not, for instance, in mercury mines. This, however, should not deceive the informed engineer. Neither should he be put off by the plea of substitution in event of exhaustion. During the war, the chemist came rapidly to the fore, and it became the popular idea that a synthetic substitute, as good as the original, could be found to replace every waning mineral product. The rapid draft on our known supplies must loom large in the mind of every alert engineer.

While exploitation permanently destroys orebodies, the metal won from them is not lost so rapidly. In its new guise, it may continue to exist and be useful for long periods, in contrast to the products of agriculture, forestry, and most other primary industries. The result is a gradual accumulation of stocks, in more or less readily available and usable condition, particularly marked in the precious or semiprecious metals, which eventually becomes a factor in world supply. Although vast quantities of gold exist in other than monetary forms, in 1930 more than half of all the gold produced in the last ten centuries was actually in the form of monetary stocks that were valued at $11,522,579,000. Such an amount of gold, by the bye, would make a cube only about 31 feet on an edge. The annual production of $400,000,000 of new gold is thus less than 4 per cent of the total stocks. The more valuable and highly prized the metal is, and the less susceptible to oxidation or chemical change, the longer it lasts, although there are huge accumulations even of as common and chemically unstable a metal as iron, and the annual production of new iron constitutes a small fraction of the total. From the repeated manufacture and use of the stocked metals comes scrap, and this often constitutes an important source, and helps to postpone the exhaustion of supply of virgin metal.

Now let us briefly review the mining situation in Canada. We are all familiar with the discoveries of gold at Porcupine in 1909, Kirkland Lake in 1912, and Rouyn in 1924, and the consequent rise in gold production until Canada is now second only to South Africa as a gold-producing nation. The new finds at the Premier in 1910, Flin Flon in 1915, Sherrett's Cold Lake property in 1923, and the deep-seated ore at the Frood mine in 1925, have been encouraging episodes. Since 1920, the Sullivan mine has become the outstanding lead-zinc producer of the world. Other promising properties are coming along, and the public interest is intrigued by such names as Great Bear Lake, Copper Mines River, Pascalis, and others.

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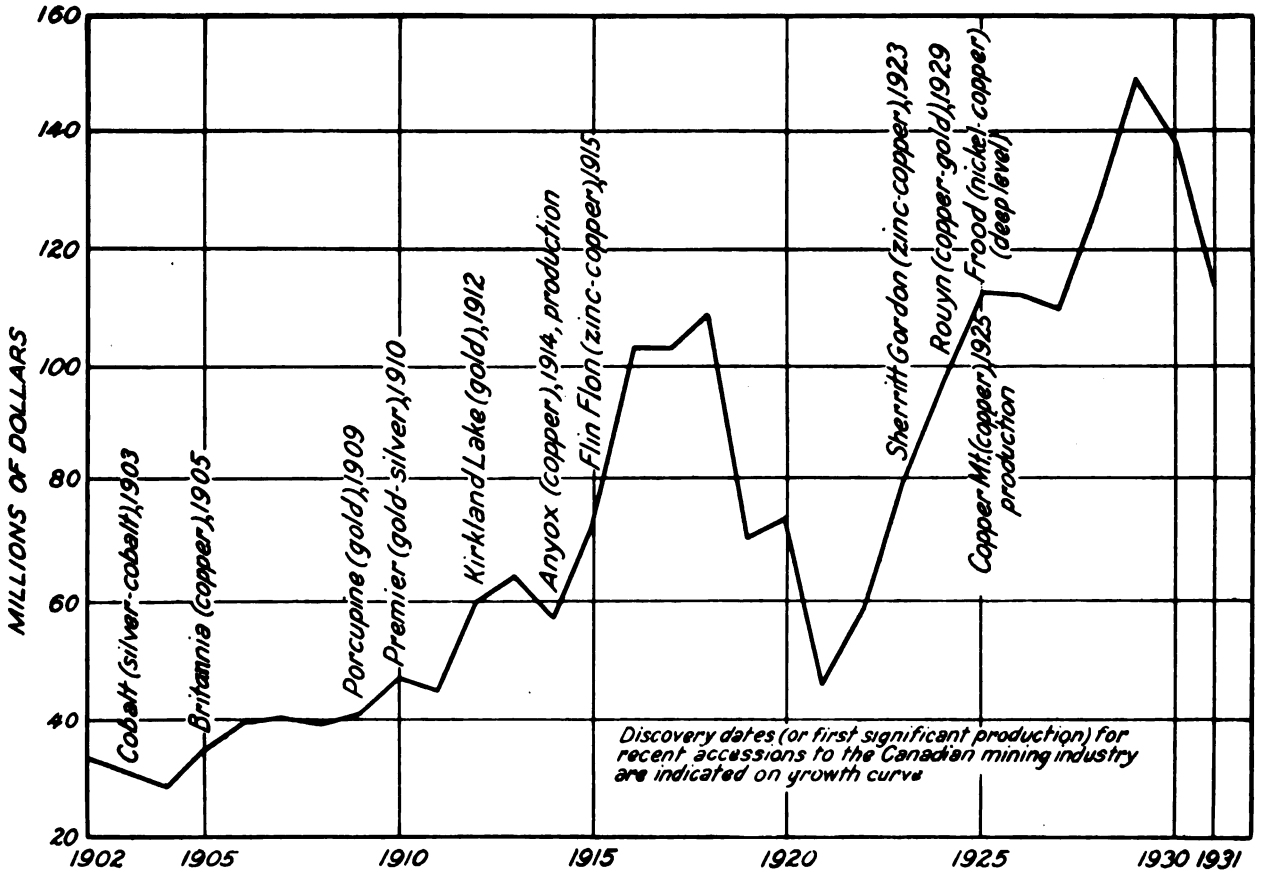

Figure 1.- Composite growth in production of gold, silver, copper, lead, zinc, and nickel (value) for Canada, 1902 - 1931

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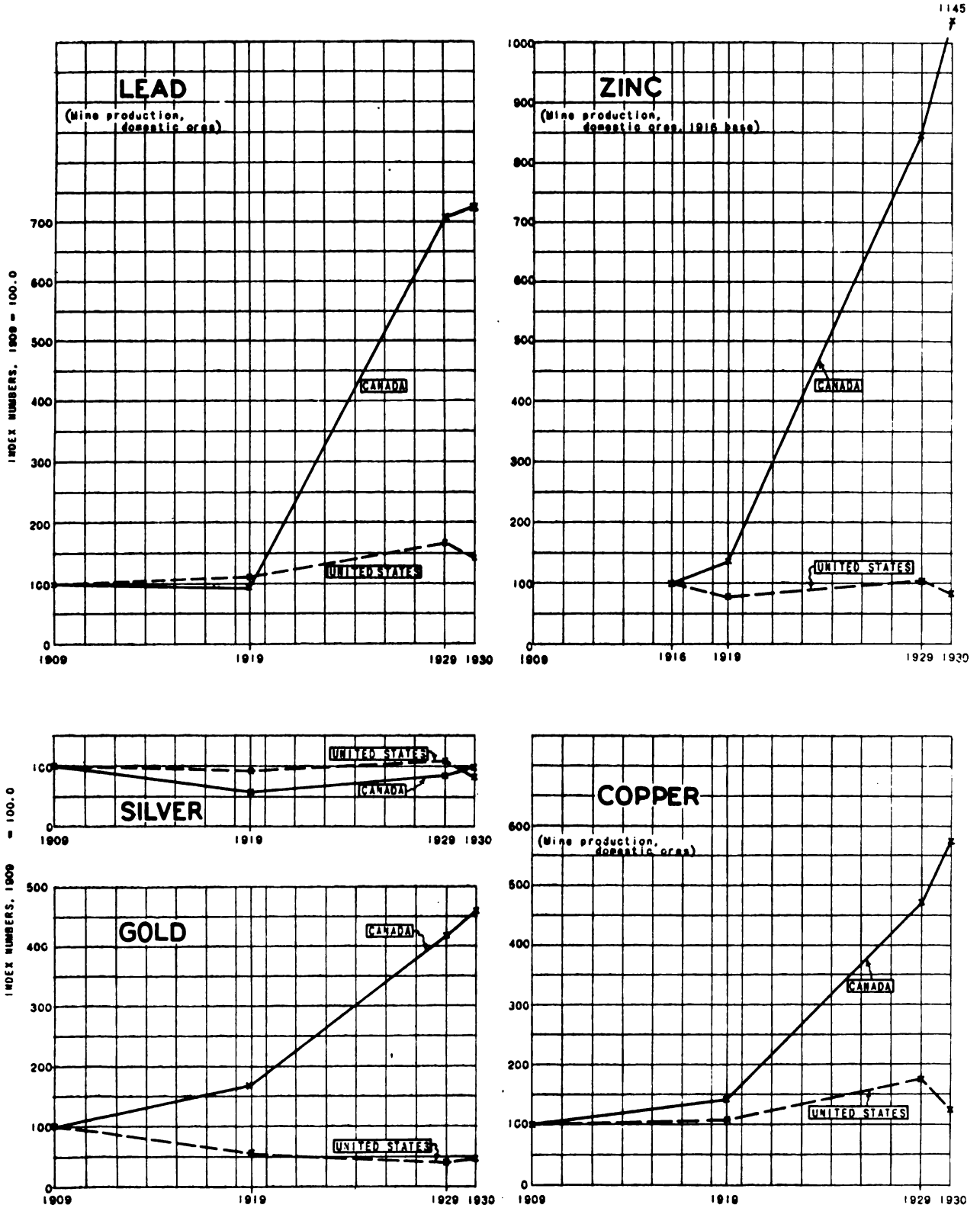

Figure 2.- Relative growth of metal production in Canada and the United States, 1909 to 1930

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American engineers realize generally that Canadian mineral production is growing (see fig. 1), but only those who have had occasion to examine the figures appreciate the rapidity of this growth. American tonnages are the product of a population of 123 million people, and in comparing the two countries it is essential to take into account the smaller population of the Dominion. Another good way to do that is to compare, not the actual quantities, but rather index numbers representing the output of each country. This is done in Figure 2. For example, if we indicate the American production of lead in 1909 by the number 100, then the American production in 1919 is represented by the number 110 and in 1929 by the number 166. In other words, the American lead output shows an increase of 66 per cent in the 20 years.

Production of gold, silver, copper, lead, and zinc
(recoverable mine output) for Canada and the United States

	1909	1919	1929	1930
Gold:				
United States (1)	4,798,342 ounces	2,753,282	2,219,613	2,138,723
	(100.0)	(57.4)	(42.9)	(44.6)
Canada	453,865	766,764	2,058,993	2,102,068
	(100.0)	(168.9)	(424.9)	(463.1)
Silver:				
United States	57,312,677 ounces	51,899,460	60,860;011	47,724,903
	(100.0)	(90.6)	(106.2)	(83.3)
Canada	27,529,473	16,020,657	23,143,261	26,443,823
	(100.0)	(58.2)	(84.1)	(96.1)
Copper:				
United States	1,126,521,126 pounds	1,212,334,041	1,995,110,398	1,410,147,374
	(100.0)	(107.6)	(177.1)	(125.2)
Canada	52,493,863	75,053,581	248,120,760	303,478,356
	(100.0)	(143.0)	(472.7)	(578.1)
Lead:				
United States	398,036 short tons	429,589	647,995	558,951
	(100.0)	(107.9)	(162.8)	(140.4)
Canada	45,857,424 pounds	43,827,699	326,522,566	332,894,163
	(100.0)	(95.6)	(712.0)	(725.9)
Zinc:				
United States	703,169 short tons	548,847	724,478	595,445
	(100.0)(1916)	(78.1)	(103.0)	(84.7)
Canada	23,364,760 pounds	32,194,707	197,267,087	267,643,505
	(100.0)	(137.8)	(844.3)	(1145.5)

Note: Figures in parentheses are index numbers base = 100.0 for 1909, except for zinc base = 100.0 for 1916.

1 - Not including Philippine Islands.

The Canadian output has grown much faster. From index 100 in 1909, it has climbed to index 712 in 1929. In other words, though Canada still mines less lead than the United States, its production has increased 612 per cent during a time when that of the United States increased 66 per cent.

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Much the same condition is shown for zinc, copper, and gold. Only in silver does the growth-trend of the United States parallel that of Canada.

For 1930, production of the nonferrous metals fell off in the States, but in Canada lead held its own in spite of the depression, and zinc and copper rose to new heights. This behavior of Canadian output under the difficult conditions of the depression is due to complex economic reasons.

We have seen that this rapid expansion has brought Canada's per capita mineral production to high levels. As before stated, counting all minerals, the United States' production per capita is still higher; but considering only the precious and the nonferrous metals, Canada now outranks the United States. Grouping together all metals except pig iron and aluminum for Canada, and pig iron for the United States, we find that in 1929 the Canadian output was $15.50 for every man, woman, and child in the Dominion, as against $7.66 in the United States.

The comparison for the individual metals is shown graphically in Figure 3.

Comparison of per capita mineral production of Canada and the United States

		Canada	United States
Gold	value	$4.39	$0.38
Copper	pounds	30.5	11.41
Lead	do.	33.4	9.3
Zinc	do.	26.8	7.9
Silver	do.	2.67	.41

The foregoing tabulation shows that in 1929 Canada produced $4.39 in gold per capita of population, while the United States produced only $0.38. In the Dominion, copper production was nearly 3 times, lead not quite 4 times, zinc almost 4 times, and silver over 6 times the corresponding per capita production in the States. On the other hand, production figures of pig iron, coal, oil, and gas show a large margin for the United States as compared to the Dominion.

So far, we have been considering various minerals; it should be noted that, in the world as a whole, the largest and most valuable of the mineral deposits are not the metals, but rather the fuels. The world picture is shown in Figure 4, in which the figures shown for value of world production of all minerals were calculated as follows: World production figures in terms of quantity were obtained for 36 of the principal minerals. Each of these was multiplied by the average value f.o.b. mine or smelter in the United States, except for coal, the foreign production of which was assigned a value 50 per cent greater than the average value f.o.b. mine in the United States. There remained a group of minerals, including clay, lime, sand, gravel, and stone, for which no satisfactory figures of world production could be developed. The production of these, however, was known for the United States, and the production for the rest of the world was estimated by assuming that it bore the same ratio to coal production as in the United States.

The results obtained by this method based on 36 minerals differ slightly from those based on 13 minerals used in the table of historical comparisons on page 3.

In 1929, the total value of the world's production of all minerals has been variously estimated at 13¼ to 14½ billion dollars. This figure represents the value at the mine or smelter. If one were to consider the additional value conferred by refining and processing petroleum and coal, or by fabricating the raw material into manufactured goods, the figure would, of course, be far larger. Of the grand total of 13¼ billions measured in this way,

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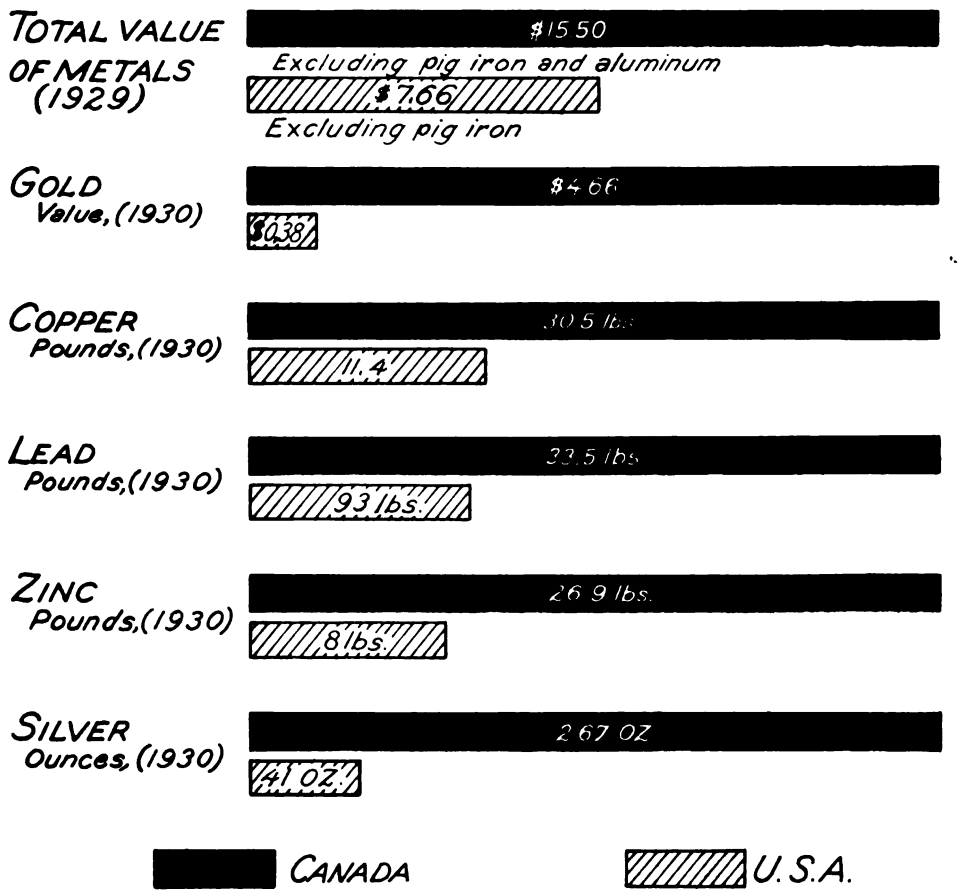

Figure 3.- Per capita production of metallic products in Canada and the United States, 1930

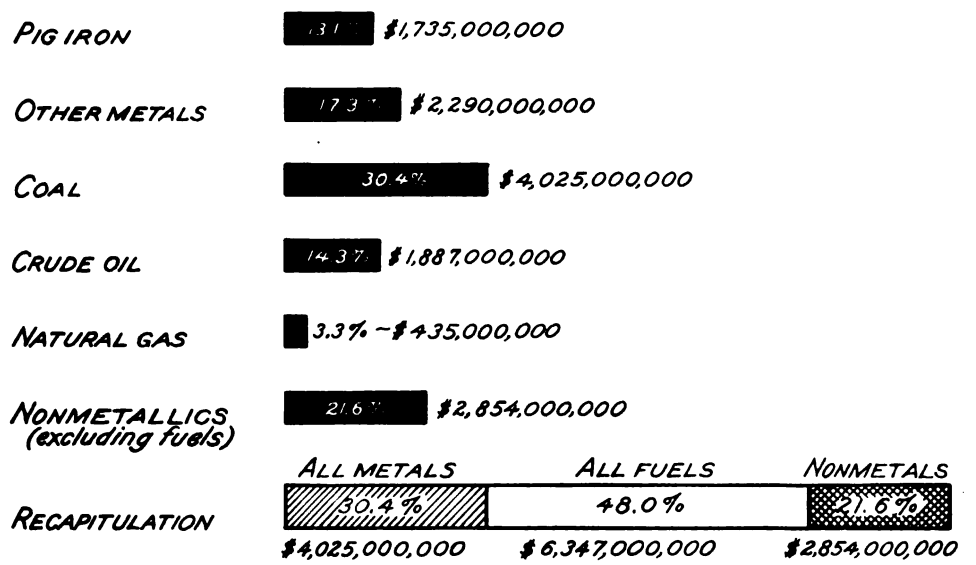

Figure 4.- Comparative values of world production of metals, fuels, and other nonmetals

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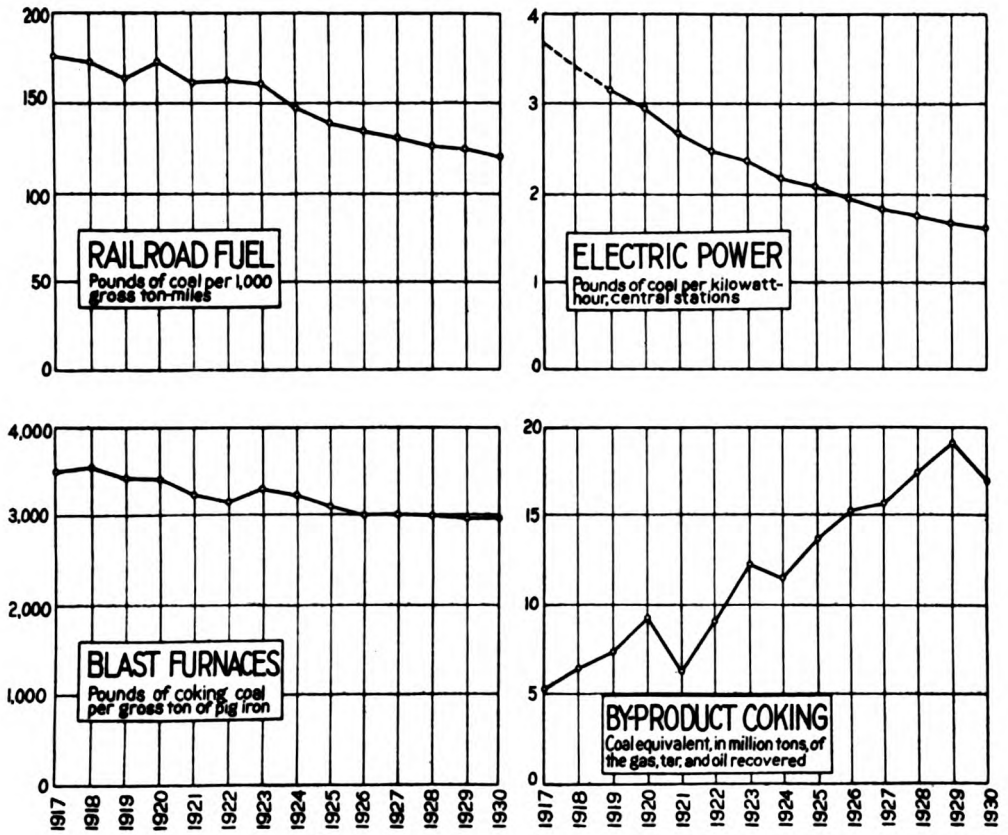
RAILROAD FUEL
Pounds of coal per 1,000 gross ton-miles
ELECTRIC POWER
Pounds of coal per kilowatt-hour, central stations
BLAST FURNACES
Pounds of coking coal per gross ton of pig iron
BY-PRODUCT COKING
Coal equivalent, in million tons, of the gas, tar, and oil recovered
1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930

Figure 5.- Increased efficiency of coal utilization and production of coal equivalents, 1917 - 1930

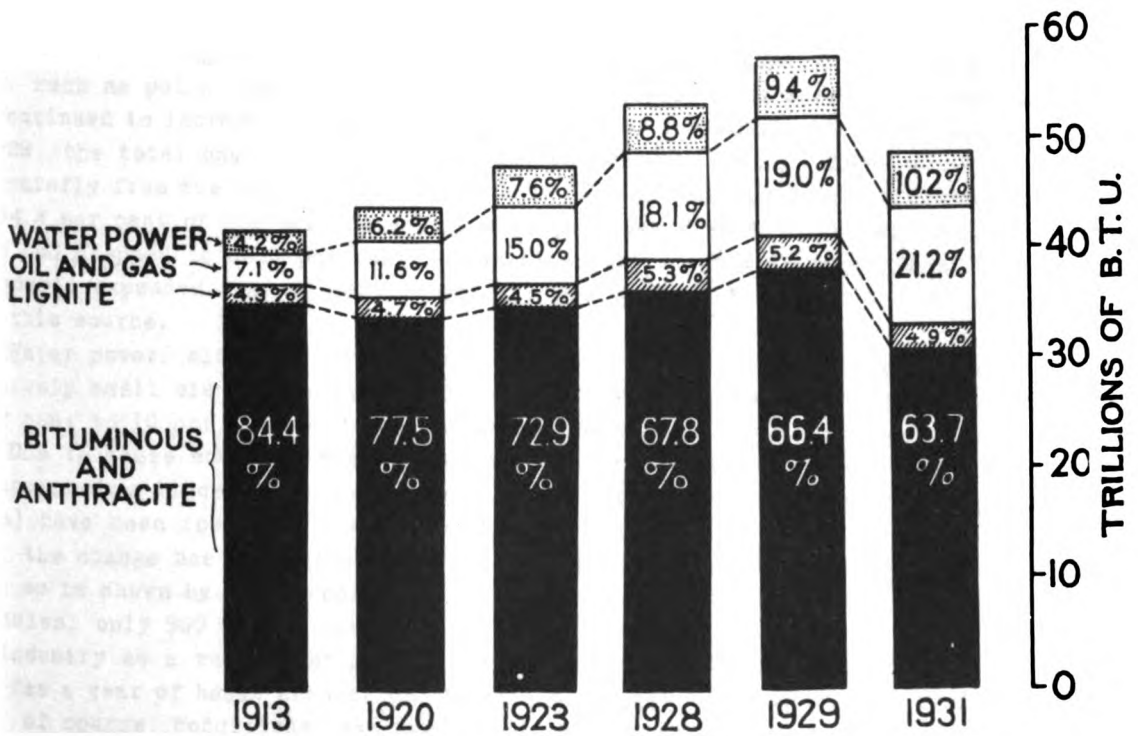

Figure 6.- Trend of the world's consumption of energy, 1913 to 1931

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the mineral fuels contributed 48 per cent, the metals 30.4 per cent, and the nonmetallics 21.6 per cent. Pig iron contributed 13.1 per cent, as compared with 17.3 per cent for all other metals. Coal, with 34.4 per cent, exceeded by far the value of any other mineral. The value of the production of the anthracite mines of Pennsylvania alone is usually greater than, but is now practically equal to, the value of the gold production of the entire world.

To complete the picture we may note that crude oil and natural gas contributed 14.3 per cent and 3.3 per cent to the total, respectively.

In view of the great importance of the fuels, it is in order to sketch some of the outstanding tendencies in the world position of these commodities.

On the technical side, the record of the coal industry in recent years is one of brilliant achievement. On both sides of the Atlantic, a revolution in underground methods is under way. In the United States, and in Canada, too, this development centers around the mechanization of loading: parallel advances have been made in other underground operations and on the surface. The net effect of these changes is seen in the output per man per day, which has jumped from 3.61 in 1913 to 5.03 tons in 1930.

In contrast to this record of technical achievement, the economic position of the coal industry is far from satisfactory. A so-called world fuel surplus exists, much like the agricultural surplus, about which so much has been said and to remedy which so little apparently can be done.

In the case of coal, the underlying causes are clear. High prices associated with the war encouraged opening new mines, and great expansion of productive capacity. The same causes that prompted the operator to increase his facilities, prompted the consumer to improve the efficiency of combustion. From being an academic discussion, fuel economy became an organized movement. The results are found in all countries. For the United States the outstanding tendencies are outlined in Figure 5. The largest savings were made by the electric central stations, whose coal consumption per kilowatt-hour fell from 3.7 pounds in 1917 to 1.62 pounds in 1930. Similar results were obtained in locomotives, in blast furnaces, and in fact wherever records of fuel performances are kept; the wasteful beehive coke-oven was displaced by the by-product oven.

Scarcely less important than efficiency in the use of fuel, is the shift in the sources of the world's energy-supply. Coal is meeting increased competition from other sources of power, such as petroleum, natural gas, and water power. The world's consumption of energy has continued to increase in spite of the progress of fuel-utilization efficiency. From 1913 to 1929, the total energy-demand increased nearly 40 per cent. The increase, however, has come chiefly from the competitors of coal. In 1913 bituminous coal and anthracite contributed 84.4 per cent of the world's energy-supply. (See fig. 6.) In 1929 their proportionate share had dropped to 66.4 per cent. Meanwhile, the relative proportion of oil and gas had enormously expanded, and in 1929 roughly 19 per cent of the world's energy-demand was met from this source.

Water power, also, has shown great increase, particularly in Canada, but it remains a relatively small element in the world total. Viewing the world as a whole, something like 9 per cent to 10 per cent of the total energy-demand is now met by hydro-power.

Due to these economic conditions, the coal industry has undergone a long and painful retrenchment. Since 1923, more than 3,000 bituminous mines (commercial mines, not wagon mines) have been forced to close, and 250,000 men have lost their jobs. On the operator's side, the change has brought heavy financial loss. In most cases nothing was left for profits, as is shown by the corporation tax returns. In 1929, out of 2,300 American bituminous companies, only 900 made a profit. The remaining 1,400 companies operated at a loss, and the industry as a whole sustained a net loss of $11,000,000 for the year. Remember that 1929 was a year of heavy production, the sixth largest in the history of the business. Since 1929, of course, conditions have grown still more difficult.

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Canadians perhaps think we are overcharging them for export coal. The plain fact is that consumers on both sides of the boundary have been getting their coal for less than they might reasonably be asked to pay. Aside from the question of tariffs, American coal is more accessible to consumers in the industrial sections of Ontario than it is to many consumers in the States.

The situation in oil is much the same. Overproduction and falling prices characterize the present position of the industry. While some results have been obtained from the efforts to control production, the market has been glutted and prices have been unreasonably low over much of the post-war period.

More recently we have witnessed a world tendency to overproduction in the metals. Although agreements to stabilize the market have been discussed, capacity to produce the base metals seems to have been growing faster than the demand. The problem of adjusting world supply to obvious limitations of world demand concerns all mineral producers. We have witnessed the tragedy of the agricultural surplus, the excesses in coal and petroleum. It seems pertinent to suggest that the warning signals be heeded with respect to the metals.

In this connection, careful thought must be given to the problem I have already mentioned: the steady accumulation of stocks of metals above ground and the increasing supplies of scrap material which return to plague the mining industry. Likewise, the tendency to expand capacity, unmindful of the influence of an excess of only 5 or 10 per cent upon the price structure for the whole industry, should be deferred until such time as consumptive needs are fully proved. Canadian and American mining companies have much the same interests, and will profit by joining hands to promote them.

We have been dealing largely with production-figures showing how Canada and the United States stand competitively. Let us now note how they supplement each other. Taken together, the two countries make a remarkably self-sufficient combination as far as minerals are concerned. In sheer volume, they dominate the world supply. Of the total value of mineral products for the world as a whole, the two countries contribute just about half — in 1929, 47.1 per cent, to be exact. This percentage is based on an estimated total value of world mineral production of 13¼ billion dollars, as developed in Figure 4 and explained previously. In addition, the variety of their minerals is more complete than that of any other continent.

Since both countries are large producers, it might be supposed that they would also be fierce competitors. The element of competition is present, but it is important to realize that the mineral relations of the two countries are much more complementary than they are competitive. This complementary relation is brought out clearly in Figure 7.

Each country is an important producer of the metals, especially of copper, lead, zinc, gold, and silver, but each relies heavily upon the other for indispensable materials. First among Canada's unique contributions to the combination are its nickel and high-grade asbestos, virtually the world's supply of each, and its cheap, abundant, and convenient hydroelectric energy. The latter is already the basis of a rapidly developing electrometallurgical industry, and promises to play a role second only to that of her metallic resources in the development of a great mining and metallurgical empire.

On the other hand, the United States contains great reservoirs of oil and gas of which thus far Canada has insufficient supplies, and also deposits of high-grade coal so situated as to be the natural source of supply for Central Canada. In fact, American coal is said to be available to many Canadians at prices lower than those paid by many citizens of the United States. In iron and steel, also, the States are in position to supply Canadian industries cheaply and well.

Notwithstanding the generous share of the world's resources which the two countries enjoy, there are other minerals for which they depend upon outside sources. Conspicuous among these have been potash, nitrates, and platinum. In each of the three, however, recent

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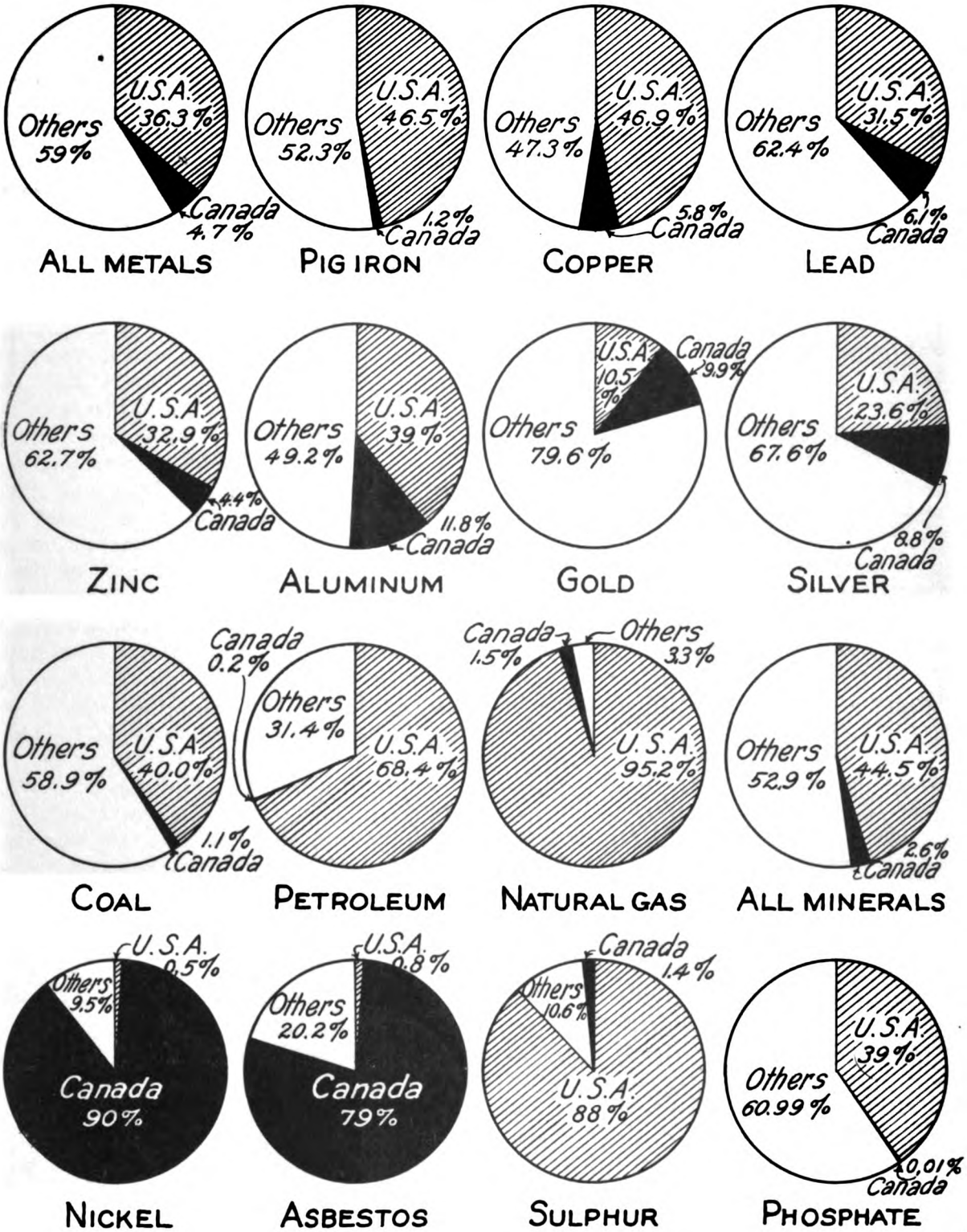

Figure 7.- Percentage of the world's mineral production contributed by Canada and the United States

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developments promise supplies that may go far in meeting the needs of both countries — platinum from Sudbury, potash from the American Southwest, and synthetic nitrates from fixation of atmospheric nitrogen. There remain a few minerals for which North America must still depend on the outside world, but who would care to say that the vast extent of the combined areas may not still contain some of the tin, manganese, and chromite needed to complete the mineral sufficiency of this continent?

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